Claims

1. A method of detecting contact between a surface and a capillary for dispensing liquids by action of a piezoelectric transducer disposed on said capillary comprising measuring the voltage produced by said piezoelectric transducer when said capillary contacts said solid surface.

2. A method of claim 1, wherein said produced voltage is measured when said capillary is not dispensing liquid.

3. A method of claim 1, wherein said produced voltage is distinguished from random voltage produced by the transducer from sources unrelated to dispensing liquids or contacting of said capillary with a surface.

4. A method of claim 3, wherein said produced voltage is amplified and compared with a baseline voltage.

5. A method of detecting contact between a surface and a capillary for dispensing liquids by action of a piezoelectric transducer disposed on said capillary comprising:

(a) providing an oscillating voltage to said capillary at its resonant frequency to establish a signal corresponding to the capillary and creating an inverted signal at the resonant conditions as a reference, whereby the signals of the capillary and the reference are in phase with each other,

(b) measuring the phase shift between the signals of (a) which results when said capillary contacts said surface and causes the signal of the capillary to change relative to said reference signal.

6. A method of claim 5, wherein said phase shift is measured when said capillary is not dispensing liquid.

7. A method of claim 5, wherein said piezoelectric transducer is supplied in (a) with a voltage lower than the voltage required to dispense liquids.

8. A method of claim 5, wherein said resonant frequency is predetermined and used in step (a).

9. A method of claim 5, wherein the signal of the capillary and the reference signal are summed and the resulting voltage change is measured to indicate said phase shift.

10. An apparatus for dispensing microdrops of liquid comprising:

(a) at least one capillary for containing liquid and from which liquid microdrops are dispensed;

(b) a piezoelectric transducer disposed on said capillary, said transducer exerting pressure on liquid in said capillary when a voltage pulse is applied to said transducer , thereby dispensing liquid microdrops;

(c) means for positioning said capillary with respect to a predetermined location;

(d) means for measuring the voltage produced by said transducer when said capillary contacts a surface.

11. An apparatus of claim 10, wherein said piezoelectric transducer surrounds said capillary.

12. An apparatus of claim 10, wherein said voltage pulse of (b) is in the range of 40 to 300 volts.

13. An apparatus of claim 10, wherein said produced voltage of (d) is distinguished from voltage produced by said transducer from random unrelated sources.

14. An apparatus of claim 10, wherein further comprising means for preventing further contact of said capillary with said surface by stopping the means for positioning said at least one capillary.

15. An apparatus of claim 10, wherein said capillary is mounted on a movable support capable of positioning said capillary in a predetermined location.

16. An apparatus of claim 15, wherein said movable support is capable of positioning said capillary in a first location for aspirating said liquid and in a second location for dispensing microdrops of said liquid.

17. An apparatus of claim 16, wherein said first location is a well of a microplate and said second location is a planar surface.

18. An apparatus of claim 17, wherein said planar surface is a glass slide.

19. An apparatus of claim 10, wherein said capillary is mounted on a support and containers for said liquid and surfaces for receiving dispensed microdrops are mounted on movable supports capable of positioning said containers or surfaces under said capillary.

20. An apparatus of claim 19, wherein said container for liquid is a well of a microplate and said surface for receiving dispensed microdrops is a planar surface.

21. An apparatus of claim 20, wherein said planar surface is a glass slide.

22. An apparatus for dispensing microdrops of liquid comprising:

(a) at least one capillary for containing liquid and from which liquid microdrops are dispensed;

(b) a piezoelectric transducer disposed on said capillary, said transducer exerting pressure on liquid in said capillary when a voltage pulse is applied to said transducer, thereby dispensing liquid microdrops;

(c) means for positioning said at least one capillary with respect to a predetermined location;

(d) means for supplying an oscillating voltage to said capillary at its resonant frequency, and establishing a signal corresponding to the capillary, and creating an inverted signal at the resonant conditions as a reference in phase with the capillary signal.

(e) means for measuring the phase shift when said capillary contacts said surface and causing the frequency of the capillary to change relative to the reference signal.

23. An apparatus of claim 22, further comprising a means for determining said resonant frequency.

24. An apparatus of claim 22, wherein said means for measuring said phase shift includes means for summing the capillary signal and the inverted signal and measuring the resulting voltage and detecting a change.

25. An apparatus of claim 22, wherein said supplied voltage is lower than that required to dispense liquids.

26. An apparatus of claim 22, wherein said piezoelectric transducer surrounds said capillary.

27. An apparatus of claim 22, wherein said voltage pulse of (b) is in the range of 40 to 300 volts.

28. An apparatus of claim 22, wherein further comprising means for preventing further contact of said capillary with said surface by stopping the means for positioning said at least one capillary.

29. An apparatus of claim 22, wherein said capillary is mounted on a movable support capable of positioning said capillary in a predetermined location.

30. An apparatus of claim 29, wherein said movable support is capable of positioning said capillary in a first location for aspirating said liquid and in a second location for dispensing microdrops of said liquid.

31. An apparatus of claim 30, wherein said first location is a well of a microplate and said second location is a planar surface.

32. An apparatus of claim 31, wherein said planar surface is a glass slide.

33. An apparatus of claim 22, wherein said capillary is mounted on a support and containers for said liquid and surfaces for receiving dispensed microdrops are mounted on movable supports capable of positioning said containers or surfaces under said capillary.

34. An apparatus of claim 33, wherein said container for liquid is a well of a microplate and said surface for receiving dispensed microdrops is a planar surface.

35. An apparatus of claim 34, wherein said planar surface is a glass slide.

36. In a capillary for dispensing microdrops of liquid by applying pressure to said liquid with a piezoelectric transducer disposed on said capillary and actuated by a voltage pulse, the improvement comprising means for measuring the voltage change produced by said transducer resulting from contact of said capillary with a surface.

37. A capillary of claim 36, wherein said produced voltage is at least 10 millivolts.

38. A capillary of claim 36, wherein said produced voltage is distinguished from voltage produced by said transducer from random sources unrelated to dispensing liquids or contacting of said capillary with surfaces.

39. In a capillary for dispensing microdrops of liquid by applying pressure to said liquid with a piezoelectric transducer disposed on a capillary and actuated by a voltage pulse, the improvement comprising means for supplying an oscillating voltage to said capillary at its resonant frequency and establishing a signal corresponding to said capillary and for measuring the phase shift compared to an inverted signal at resonant conditions when said capillary contacts a surface.

40. A capillary of Claim 39, wherein said improvement further comprises a means for predetermining said resonant frequency.

41. A capillary of claim 40, wherein said voltage supplied to said capillary at its resonant frequency is lower than that required to dispense liquids.

42. A method of claim 1 wherein said voltage produced by said piezoelectric transducer is used to prevent further contact of said capillary with a surface by stopping movement of said capillary relative to said surface.

43. A method of claim 5 wherein said phase shift resulting from contact of said capillary with a surface is used to stop movement of said capillary relative to said surface.